REMARKS

In view of the above amendments and arguments herein, Applicants believes the pending application is in condition for allowance.

I. Status of the Claims

Claims 14, 16 - 28, 41 - 48 and 55 - 57 are presently pending are currently pending, with claims 1 - 13, 15, 29 - 40 and 49 - 54 having previously been cancelled. In the present Response, Applicants amend claims 14. No new matter is introduced. Support may be found in Applicants' specification, for example, at page 10, lines 19 - 21, page 21, lines 14 - 24, page 27, line 16 through page 28, line 12, and page 44, line 19 through page 45, line 2.

II. Rejections under 35 U.S.C. § 103

Claims 14, 17 and 20 - 22 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,000,819 to Pedder et al. ("Pedder") in view of U.S. Patent No. 5,895,558 to Spence ("Spence"). Claims 16 and 18 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Pedder and Spence in view of U.S. Patent No. 5,409,543 to Panitz et al. ("Panitz"). Claim 19 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Pedder and Spence in view of U.S. Patent No. 5,345,056 to Frei et al. ("Frei"). Claims 23 - 25, 27, 28, 41 - 44, 46 and 47 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,921,157 to Dishon et al. ("Dishon") in view of Frei. Claim 26 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Dishon in view of Frei and Panitz. Claims 45 and 48 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dishon in view of Frei and U.S. Patent No. 6,288,451 to Tsao ("Tsao"). Claim 55 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Dishon in view of Frei and U.S. Patent No. 6,095,397 to Wolf et al. ("Wolf"). Claims 56 and 57 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dishon in view of Frei, Tsao and Wolf.

Applicants amend claim 14 to further clarify the nature of their invention, and respectfully traverse these rejections.

In amended claim 14, Applicants claim:

14. A solder bump forming apparatus adapted to use a soft solder alloy on the surface of a workpiece to form solder bumps, which will serve as connecting terminals, said solder bump forming apparatus including:

a plasma generating means adapted to generate at least hydrogen-containing plasma under a low pressure, the plasma generating means being provided with:

a high frequency power supply and an electrode connected to said high frequency power supply and adapted to generate plasma, said electrode having: a hollow electrode body adapted to receive a process gas,

supply openings that are adapted to feed the process gas and bored in an end of the electrode body facing away from the workpiece, the supply openings being configured so that plasma proceeding through the supply openings is directed away from the workpiece, and

through holes bored through the electrode body so as to extend from the end where the supply openings are formed through to an opposite end of the electrode body facing toward the workpiece;

a gas supply means for feeding process gas to the plasma generating means;

a workpiece exposing means for exposing the soft solder alloy on the surface of the workpiece at least to hydrogen-containing plasma; and

a heating means for applying a reflow treatment the soft solder alloy in a vacuum,

wherein the supply openings are each positioned adjacently to at least one of the through holes, so that the plasma exiting through the supply openings away from the workpiece passes into the through holes moving toward the workpiece after exiting the supply openings, the through holes being operable for trapping plasma ions in the plasma.

(Emphasis added).

Pedder discloses a dry solder reflow process which removes metal surface oxides from the solder surface by abstraction of the oxygen from the metal oxide by atomic hydrogen generated in a microwave plasma of hydrogen gas (see, e.g., abstract of Pedder). Pedder teaches that a suitable plasma may be generated by a 200 watt, 2.45 GHz microwave generator operating in a small

tunable microwave cavity that generates a gas flow flowing through a conical section and an "earthed microwave shield in the form of a perforated plate" toward a workpiece (see, e.g., Col. 3: 35- 56).

In sharp contrast to the microwave shield disclosed by Pedder, Applicants' claimed electrode includes a hollow body for receiving supply gas and supply openings which are bored into an end surface of the hollow body and through holes which extend through the hollow body from the end surface at which the supply openings are provided through to a surface at an opposite end (see, e.g., page 25, line 9 through page 26, line 6 of Applicants' specification). Thus, Pedder's disclosed microwave shield fails to include or suggest each of the claimed elements in Applicants' electrode.

The Examiner acknowledges that Pedder fails to teach "a hollow body electrode adapted to receive a process gas having supply opening for feeding process gas to the plasma chamber," and suggests that this deficiency is cured by Spence.

Spence discloses a plasma discharge device for roughening surfaces of substrates (see, e.g., Col. 1: 15 - 20 of Spence). Spence discloses one or more plasma-generating electrodes having "a series of holes extending through the electrode face for supply gas flow" (see, e.g., Col: 2: 65 - Col. 3: 4 of Spence). However, with reference for example to Applicants' FIG. 1B, the combination of Pedder and Spence still fails to teach of suggest Applicants' claimed electrode having supply openings that are bored in an end of the electrode facing away from a workpiece direction of the electrode and that are adjacent to through holes which extend from end of the electrode facing away from the workpiece direction to an opposite end of the electrode facing the workpiece direction, thereby enabling plasma exiting through the supply openings to then pass into the through holes moving in a direction toward the workpiece.

These elements of Applicants' claimed electrode perform a unique function. Plasma ions which are ejected through the supply openings pass into adjacent through holes, which serve as "H tunnels" for trapping plasma ions as the plasma passes through the through holes. This trapping of plasma ions prevents a violent collision of ions with the workpiece, thereby protecting a passivation

film and/or other components of the workpiece from damage (for example, physical etching caused by collisions with the ions). This enables active species that are generated during the plasma reaction, for example, to pass through the through holes to etch the workpiece by means of a soft, chemical reaction (see, e.g., page 27, line 16 through page 28, line 12 of Applicants' specification).

Accordingly, Applicants respectfully submit that the combination of Pedder and Spence fails to teach or fairly suggest each and every element of Applicants' invention as claimed in amended independent claim 14, and the independent claim 14 is therefore allowable. As claims 16 - 22 each depend from allowable claim 14, Applicants further submit that dependent claims 16 - 22 are also allowable for at least these reasons.

Claims 23 - 25, 27, 28, 41 - 44, 46 and 47 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dishon in view of Frei. Applicants respectfully traverse these rejections.

Each of independent claims 23, 41, 43 and 46 disclose either a method or apparatus for soldering. Each claimed apparatus includes components that essentially provide for a soldering process as is claimed in amended independent claim 23:

> **23.** A bump forming method for forming bumps, which will serve as connecting terminals, on the surface of a workpiece by following the procedure that comprises the steps of:
>
> roughening the surface of a soft solder alloy accumulated on the surface of the workpiece;
>
> applying a surface reforming treatment to form a layer containing fluorine on the roughened surface of the soft solder alloy; and
>
> performing reflow of the soft solder alloy that has undergone said surface reforming treatment.

(Emphasis added).

Dishon discloses a method of soldering that uses plasma excitation to remove surface oxides from soldering surfaces via an oxide plasma treatment that is applied before a fluoride plasma

treatment (see, e.g., Col. 5: 49 - 62 of Dishon). As contrasted with Applicants' independent claims 23, 41, 43 and 46, the Examiner acknowledges that Dishon fails to "expressly teach [a] roughening process using [a] hydrogen and inert gas mixture. The Examiner however suggests that this element of Applicant's claimed invention is taught by Frei.

Frei disclose a plasma-based soldering process in which the plasma forming gas contains hydrogen and an inert gas (nitrogen). Frei however nowhere discloses or suggests that the plasma is applied for the purpose of roughening the surface of a solder alloy. In fact, notably, Frei suggests that the generated plasma species are "not reactive enough to perform etching except on some materials such as photoresist" (emphasis added, see, e.g., Col. 5: 3 - 5 of Frei). Rather, Frei teaches that by merely cleaning the surfaces of the solder bumps to remove impurities from the surfaces, a surface energy is raised in the bumps to provide an improved wetting angle for improved solder reflow (see, e.g. ., Col. 5: 5 -13 of Frei). This approach comports with the objectives of Dishon, which also teaches cleaning the surface of solder bumps for improved solderability (see, e.g., abstract of Dishon).

In sharp contrast, Applicants' claimed bump-forming method is not directed to simply cleaning a solder surface to achieve improved solderability, but is rather first directed to roughening a surface of the bumps in order to form a fluorine-containing layer that is adhered to the surface of the bump (see, e.g., page 44, line 19 through page 45, line 2 of Applicants' specification.). Clearly, as compared to Dishon or Frei, this is accomplished in Applicants' cases by a more aggressive hydrogen plasma bombardment. This provides the advantage of enabling a shorter fluorine application period, thereby minimizing the risk of damage to associated microcircuits that could be caused by an extensive fluorine application period (see, e.g., page 10, lines 19 - 21 and page 21, lines 14 - 24 of Applicants' specification).

Accordingly, Applicants respectfully submit that the process and apparatus claimed in Applicants' independent claims 23, 41, 43 and 46 is not anticipated or made obvious by the combination of Dishon and Frei, and that independent claims 23, 41, 43 and 46 therefore stand in condition for allowance. As claims 24 - 28, 42 44, 45, 47, 48 and 55 - 57 each depends from one of

allowable claims 23, 41, 43 and 46, Applicants further submit that dependent claims 24 - 28, 42 44, 45, 47, 48 and 55 - 57 are also allowable for at least these reasons.

For the above-argued reasons, Applicants respectfully request that the rejections of claims 14, 16 - 22, 23 - 28, 41 - 48 and 55 - 57 under 35 U.S.C. § 103(a) be withdrawn.

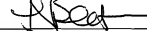
CONCLUSION

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

If there are any other issues remaining which the Examiner believes could be resolved through either a Supplemental Response or an Examiner's Amendment, the Examiner is respectfully requested to contact the undersigned at the telephone number indicated below.

Dated: November 6, 2007

Respectfully submitted,

By 

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